

# **INDOOR AIR QUALITY ASSESSMENT**

**Cerebral Palsy of Massachusetts  
Options Program  
30 Taunton Green, Unit 8  
Taunton, Massachusetts 02780**



Prepared by:  
Massachusetts Department of Public Health  
Center for Environmental Health  
Emergency Response/Indoor Air Quality Program  
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## **Background/Introduction**

At the request of Kevin Sweet, Sanitary Inspector for the City of Taunton's Department of Public Health, the Massachusetts Department of Public Health (MDPH), Center for Environmental Health (CEH) provided assistance and consultation regarding indoor air quality concerns at the Cerebral Palsy of Massachusetts, Options Program (OP) located at 30 Taunton Green, Unit 8, Taunton, Massachusetts. The request was prompted by health complaints (e.g., respiratory illness, exacerbation of allergies and headaches) suspected of being associated with mold concerns reported by several occupants. On October 28, 2005, a visit to the OP to conduct an indoor air quality assessment was made by Cory Holmes, an Environmental Analyst in CEH's Emergency Response/Indoor Air Quality (ER/IAQ) Program. Mr. Sweet accompanied Mr. Holmes during the assessment.

The OP occupies administrative office space located in a one-story, red brick and stucco building constructed in the 1972. The OP has occupied the space since 1992. The space was renovated prior to occupancy and again in 2002 to provide expansion for OP staff. Windows throughout the building are not openable.

## **Methods**

Tests for carbon dioxide, temperature and relative humidity with the TSI, Q-Trak, IAQ Monitor, Model 8551. Moisture content of porous building materials (i.e., ceiling tiles and carpeting) were measured with a Delmhorst, BD-2000 Model, Moisture Detector equipped with a Delmhorst Standard Probe. MDPH staff also performed visual inspection of building materials for water damage and/or microbial growth.

## **Results**

The OP has an employee population of approximately 15 and can be visited by up to 5 individuals daily. The tests were taken during normal operations. Test results appear in Table 1.

## **Discussion**

### **Ventilation**

It can be seen from Table 1 that carbon dioxide levels were above 800 ppm (parts per million) in thirteen of fourteen areas surveyed, indicating poor air exchange in most areas. It is important to note that at the time the tests were conducted all areas were sparsely populated or unoccupied, which further illustrates the lack of air exchange.

The heating, ventilating and air conditioning (HVAC) system consists of rooftop air handling units (AHUs) (Picture 1), which provides conditioned outside air through ducted ceiling vents (Pictures 2 and 3). Air is returned to the AHUs by ducted ceiling-mounted return vents (Pictures 4 and 5). This system was operating throughout the building during the assessment. Thermostats that control the HVAC system have fan settings of “on” and “automatic”. Thermostats were set to the fan “on” setting (Picture 6) providing continuous airflow, which is recommended by the MDPH. The “automatic” setting on the thermostat activates the HVAC system at a preset temperature. Once the preset temperature is reached, the HVAC system is deactivated.

To maximize air exchange, the MDPH recommends that both supply and exhaust ventilation operate continuously during periods of occupancy. In order to have proper ventilation with a mechanical ventilation system, the systems must be balanced subsequent

to installation to provide an adequate amount of fresh air to the interior of a room while removing stale air from the room. It is recommended that HVAC systems be re-balanced every five years to ensure adequate air systems function (SMACNA, 1994). The date of the last balancing of these systems was not available at the time of the assessment.

The Massachusetts Building Code requires that each room have a minimum ventilation rate of 20 cubic feet per minute (cfm) per occupant of fresh outside air or openable windows (SBBRS, 1997; BOCA, 1993). The ventilation must be on at all times that the room is occupied. Providing adequate fresh air ventilation with open windows and maintaining the temperature in the comfort range during the cold weather season is impractical. Mechanical ventilation is usually required to provide adequate fresh air ventilation.

Carbon dioxide is not a problem in and of itself. It is used as an indicator of the adequacy of the fresh air ventilation. As carbon dioxide levels rise, it indicates that the ventilating system is malfunctioning or the design occupancy of the room is being exceeded. When this happens, a buildup of common indoor air pollutants can occur, leading to discomfort or health complaints. The Occupational Safety and Health Administration (OSHA) standard for carbon dioxide is 5,000 parts per million parts of air (ppm). Workers may be exposed to this level for 40 hours/week, based on a time-weighted average (OSHA, 1997).

The MDPH uses a guideline of 800 ppm for publicly occupied buildings. A guideline of 600 ppm or less is preferred in schools due to the fact that the majority of occupants are young and considered to be a more sensitive population in the evaluation of environmental health status. Inadequate ventilation and/or elevated temperatures are major

causes of complaints such as respiratory, eye, nose and throat irritation, lethargy and headaches. For more information concerning carbon dioxide, please see [Appendix A](#).

Temperature readings ranged from 70° F to 75° F the day of the assessment, which were within the MDPH recommended comfort guidelines. The MDPH recommends that indoor air temperatures be maintained in a range of 70° F to 78° F in order to provide for the comfort of building occupants. In many cases concerning indoor air quality, fluctuations of temperature in occupied spaces are typically experienced, even in a building with an adequate fresh air supply.

The relative humidity measurements in the building ranged from 32 to 42 percent, which were below the MDPH recommended comfort range in all but two areas. The MDPH recommends a comfort range of 40 to 60 percent for indoor air relative humidity. Relative humidity levels in the building would be expected to drop during the winter months due to heating. The sensation of dryness and irritation is common in a low relative humidity environment. Low relative humidity is a very common problem during the heating season in the northeast part of the United States.

### **Microbial/Moisture Concerns**

A number of areas had water-damaged ceiling tiles (Picture 7). Occupants reported that ceiling tiles became damaged as a result of roof leaks that have since been repaired. Water-damaged ceiling tiles can provide a source of mold and should be replaced after a leak is discovered and repaired. MDPH staff removed ceiling tiles in a number of areas to examine conditions above the ceiling plenum. All areas appeared dry, and no visible mold growth and/or associated odors were observed/detected on the day of the assessment. In

addition, MDPH staff conducted moisture testing of water damaged ceiling tiles. In order for building materials to support mold growth, a source of water exposure is necessary. Identification and elimination of water moistening building materials is necessary to control mold growth. Materials with increased moisture content *over normal* concentrations may indicate the possible presence of mold growth. All water damaged ceiling tiles tested were found to have low (i.e., normal) moisture content (Table 1) at the time of the assessment.

Conditions on the roof were examined. Several patches for previous roof repairs were evident. One patch had become loose and leaves and other debris were observed underneath the patch (Picture 8). Breaches in seals of patches can allow water infiltration under the roof membrane. Roof drains were also observed to be clogged with leaves (Picture 9) from branches that overhang the roof (Picture 10). Clogged drains, accumulated leaves and debris can hold water on the roof where repeated freezing and thawing during winter months can damage the roof membrane and lead to water penetration.

The US Environmental Protection Agency (US EPA) and the American Conference of Governmental Industrial Hygienists (ACGIH) recommends that porous materials (carpeting, ceiling tiles, etc.) be dried with fans and heating within 24 to 48 hours of becoming wet (US EPA, 2001; ACGIH, 1989). If porous materials are not dried within this time frame, mold growth may occur. Water-damaged porous materials cannot be adequately cleaned to remove mold growth. The application of a mildewcide to moldy porous materials is not recommended.

A water cooler was located over carpeting (Picture 11). Water spillage or overflow of cooler catch basins can result in the wetting of the carpet. In addition, some of the coolers had residue/build-up in the reservoir. These reservoirs are designed to catch excess water during operation and should be emptied/cleaned regularly to prevent microbial and/or bacterial growth.

Plants were noted in several a few areas. Some plants were placed on paper plates (Picture 12). Plants should be properly maintained and equipped with drip pans. Plants should be located away from ventilation sources to prevent aerosolization of dirt, pollen or mold. Plants should not be placed on porous materials, since water damage to porous materials may lead to microbial growth.

Occupants reported that a dehumidifier is operated during periods of high outdoor relative humidity (spring and summer months). Dehumidifiers are equipped with a reservoir that holds standing water, which should be cleaned/disinfected as per the manufacture's recommendations to prevent microbial growth.

### **Other Concerns**

The copy room contained a high output photocopier. Volatile organic compounds (VOCs) and ozone can be produced by photocopiers, particularly if the equipment is older and in frequent use. VOCs are materials, which evaporate readily and can be irritating to eyes, nose and throat. Ozone is a respiratory irritant (Schmidt Etkin, 1992). Occupants should ensure local exhaust ventilation is operating near photocopiers to remove/reduce excess heat and odors.

MDPH staff inspected HVAC filters, which were located in the ceiling-mounted return vents and inside rooftop AHUs. The filter installed in the main return vent of the OP was a high-efficiency pleated filter (Picture 4). The filters installed in the AHUs were of a type that provides minimal filtration (Picture 13). In order to decrease aerosolized particulates, higher efficiency, disposable filters can be installed in the AHUs. The dust spot efficiency is the ability of a filter to remove particulates of a certain diameter from air passing through the filter. Filters that have been determined by ASHRAE to meet its standard for a dust spot efficiency of a minimum of 40 percent would be sufficient to reduce airborne particulates (Thornburg, 2000; MEHRC, 1997; ASHRAE, 1992). Note that increased filtration can reduce airflow produced through increased resistance (called pressure drop), which may be occurring due to high efficiency filters installed in the central return vent, as opposed to in the AHUs. Prior to any increase in filtration, AHUs should be evaluated by a ventilation engineer to ascertain whether they can maintain function with more efficient filters. A portable air purifier was also observed in use. These units also have filters that should be cleaned or changed as per the manufacture's recommendations.

Finally, of note was the amount of materials stored inside the OP. Items were observed on windowsills, tabletops, counters, bookcases and desks. The large number of items stored provides a source for dusts to accumulate. These items, (e.g., papers, folders, boxes) make it difficult for custodial staff to clean. Dust can be irritating to eyes, nose and respiratory tract. Items should be relocated and/or be cleaned periodically to avoid excessive dust build up.



## **Conclusions/Recommendations**

In view of the findings at the time of the visit, the following recommendations are made:

1. Increase the percentage of fresh air supplied by the HVAC as a means to improve air exchange.
2. Consult a ventilation engineer concerning re-balancing of the ventilation systems. Ventilation industrial standards recommend that mechanical ventilation systems be balanced every five years (SMACNA, 1994).
3. Consider upgrading filters in AHUs to higher efficiency pleated air filters instead of at return vents to reduce pressure drop and improve exhaust capabilities. Prior to any increase in filtration, AHUs should be evaluated by a ventilation engineer to ascertain whether they can maintain function with more efficient filters.
4. For buildings in New England, periods of low relative humidity during the winter are often unavoidable. Therefore, scrupulous cleaning practices should be adopted to minimize common indoor air contaminants whose irritant effects can be enhanced when the relative humidity is low. To control for dusts, a high efficiency particulate arrestance (HEPA) filter equipped vacuum cleaner in conjunction with wet wiping of all surfaces is recommended. Drinking water during the day can help ease some symptoms associated with a dry environment (e.g., throat and sinus irritations).

5. Continue to repair any water leaks as they may occur, and replace any remaining water damaged ceiling tiles. Examine the areas above and behind these areas for mold growth. Disinfect areas of water leaks with an appropriate antimicrobial.
6. Trim tree branches to prevent any from overhanging above the roof. Inspect and clear debris from roof drains regularly. Reseal roof patch shown in Picture 8.
7. Ensure plants have drip pans. Examine drip pans periodically for mold growth and disinfect with an appropriate antimicrobial where necessary.
8. Relocate or place tile or rubber matting underneath water coolers in carpeted areas. Clean and disinfect reservoirs as needed to prevent microbial growth.
9. Clean and disinfect dehumidifiers/humidifiers as per the manufacture's instructions to prevent microbial growth.
10. Clean supply/return vents periodically of accumulated dust.
11. Relocate or consider reducing the amount of materials stored in common areas to allow for more thorough cleaning. Clean items regularly with a wet cloth or sponge to prevent excessive dust build-up.
12. Clean/change filters for air purifier as per the manufactures instructions or more frequently if needed.
13. Refer to resource manuals and other related indoor air quality documents for further building-wide evaluations and advice on maintaining public buildings. Copies of these materials are located on the MDPH's website: [http://mass.gov/dph/indoor\\_air](http://mass.gov/dph/indoor_air)

## References

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**Picture 1**



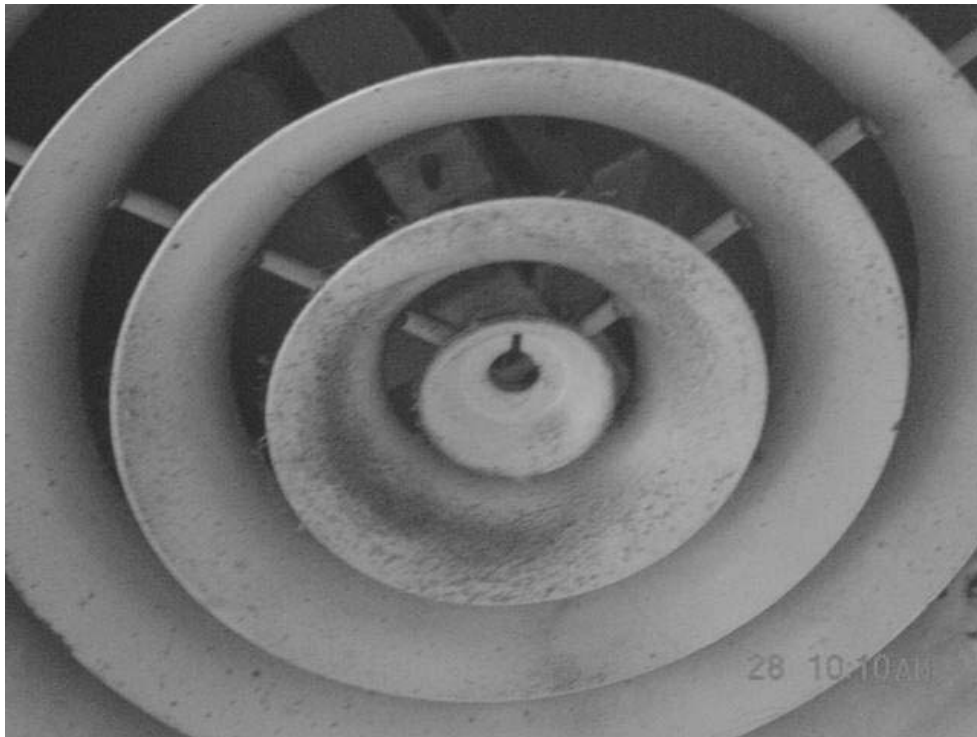
**Rooftop AHUs**

**Picture 2**



**Ceiling-Mounted Air Diffuser, Note Stained Ceiling Tile**

**Picture 3**



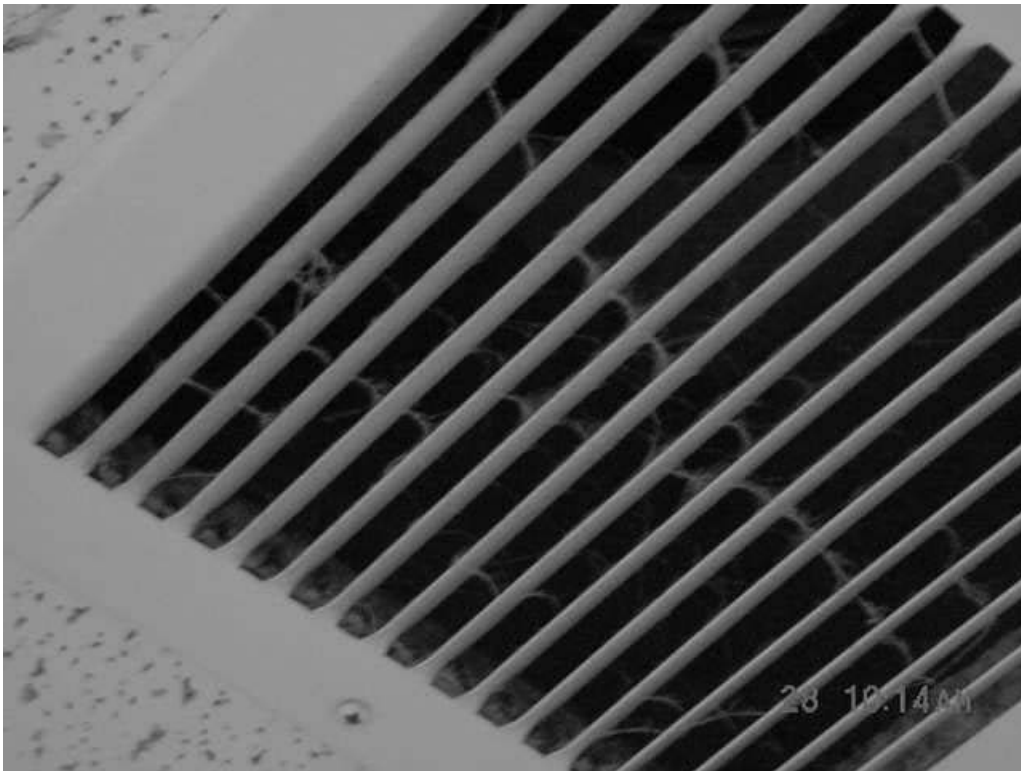
**Ceiling-Mounted Air Diffuser, Note Dust Buildup**

**Picture 4**



**Central Return Vent with High Efficiency Pleated Air Filter**

**Picture 5**



**Ceiling-Mounted Return Vent in Office**

**Picture 6**



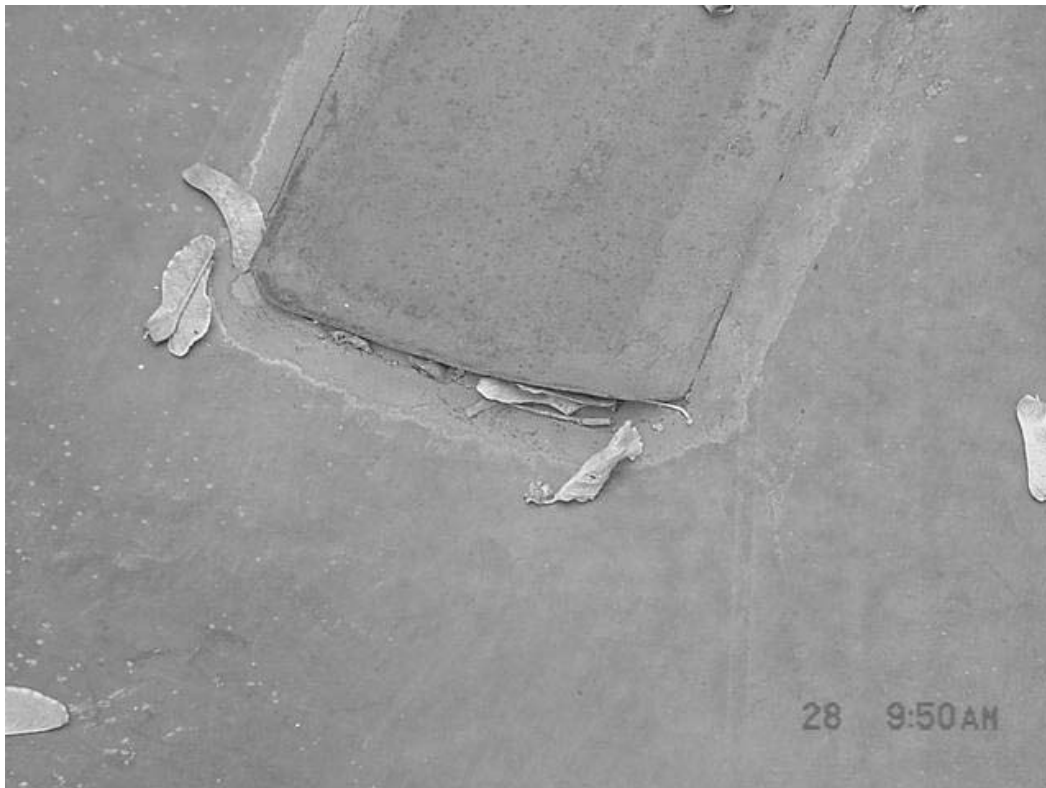
**Thermostat for HVAC System**

**Picture 7**



**Water Damaged Ceiling Tile**

**Picture 8**



**Loose Roof Patch With Leaves Underneath**

**Picture 9**



**Clogged Roof Drain**

**Picture 10**



**Trees Overhanging Roof**



**Picture 11**



**Picture 12**



**Plants on Paper Plates**

**Picture 13**



**Fibrous Mesh Filter Installed in Rooftop AHU**

TABLE 1

**Indoor Air Test Results – Cerebral Palsy of MA, Options Program, Taunton, MA – October 28, 2005**

Location	Carbon Dioxide (*ppm)	Temp (°F)	Relative Humidity (%)	Occupants in Room	Windows Openable	Ventilation		Remarks
						Supply	Exhaust	
Background								Overcast, cool, winds NNW 5 MPH
Main Hallway					N	Y	Y	2 CT-low moisture reading, plants on paper plates
Intake Coordinator	933	70	42	1	N	Y	N	Door undercut, DO
Main Office Area	985	70	40	2	N	Y	Y	1 CT-low moisture reading, water cooler on carpet
File Room	836	70	36	0	N	Y	N	1 CT-low moisture reading, DO
Case Management	820	70	35	0	N	Y	Y	Personal fan, DO
Skills Trainer	818	70	34	0	N	Y	Y	DO
Kathy's Office	796	70	33	0	N	Y	Y	DO
Jen's Office	847	71	33	2	N	Y	Y	Portable heater, DO
Desiree and Jen's Office	941	71	33	2	N	Y	Y	DO, cobwebs on return vent

\* ppm = parts per million parts of air

DO = door open, CT = water damaged ceiling tile

**Comfort Guidelines**

Carbon Dioxide - < 600 ppm = preferred  
 600 - 800 ppm = acceptable  
 > 800 ppm = indicative of ventilation problems

Temperature - 70 - 78 °F

Relative Humidity - 40 - 60%

**TABLE 1**

**Indoor Air Test Results – Cerebral Palsy of MA, Options Program, Taunton, MA – October 28, 2005**

Location	Carbon Dioxide (*ppm)	Temp (°F)	Relative Humidity (%)	Occupants in Room	Windows Openable	Ventilation		Remarks
						Supply	Exhaust	
Ann's Office	850	71	33	0	N	Y	Y	
Pat's Office	935	71	32	3	N	Y	Y	Loose CT
Break Room	874	72	32	0	N	Y	Y	4 CT 9 (1 with hole for drainage) low moisture reading
PCA Dept	1030	74	33	3	N	Y	Y	5 CT-low moisture reading
PCA Front Office	1118	75	35	2	N	Y	Y	Water damaged carpet-low moisture reading
Copy Room	1169	75	37	0	N	Y	Y	2 CT-low moisture reading

\* ppm = parts per million parts of air  
DO = door open, CT = water damaged ceiling tile

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Carbon Dioxide -	< 600 ppm = preferred 600 - 800 ppm = acceptable > 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%